

Kim-1/6502 USER NOTES

JANUARY 1977

ISSUE 3

ATTENTION!! ATTENTION!!

We've moved - here's the new address for all correspondence and subscriptions:

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To alleviate possible typographical errors, please try to submit articles in original type, single spaced on white bond so that we may cut and paste instead of re-typing. Also, if you expect a personal response to correspondence, please include a self addressed stamped envelope, to help defray expenses.

Here is a correction for issue #2. - Stan Ockers informed me that page 10 address 03AF should be 49 (not 47).

Hope you all had a happy holiday and that your happy new year will last through 1977!

✓ KIM sure had a happy new year! Two national amateur radio mags had application articles on KIM in their Jan. '77 issues! 73 Magazine showed how KIM could be set up to be a Morse Code Keyboard. (9-1000 MFW) with the addition of an ASCII keyboard and a few discrete components.

I had my morse keyboard up and running the very next day with a Sanders 720 keyboard and the read relay and transistor driver from what I had laying around the shack. Boy, what an exciting feeling to just press typewriter keys and have perfect CW going out on the air! I really enjoy rag chewing (ham lingo for chewing the fat) and the Morse keyboard makes it almost effortless. The first fellow I had a QSO (contact) with had to listen to about 10 solid minutes of CW (morse code) because once I got started hacking away at the keys, I just couldn't stop! The great advantage of the software approach to implementing a morse-code keyboard really becomes apparent when you want to add functions or otherwise change its operation.

One of our members, Carl W. Robbins WJTH, wrote the article on controlling a 2-meter repeater with KIM which appeared in the Jan '77 issue of QST Magazine. Complete schematics on KIM interfaces and full software listings are provided, which make this seem like the best way to go if you are setting a repeater and want to go the microprocessor route!

Got a letter from Eliot Friedman KB0WE, 1175 Wendy Rd., Ann Arbor, Michigan 48103. Eliot is interested in contacting other radio amateur KIM owners and perhaps forming a net where information and programs could be exchanged.

Some further comments on the Byte Shop #2 Tiny Basic tapes from Bob Grater: These cassette tapes are set up to run in KIM with 4K of memory added from 0400-13FF. If you want Tiny Basic for the area above the KIM Monitor (address 2000 on up) then you will have to get the paper tape version which costs \$7.50 and includes the manual. The cassette version runs \$9.50. Include \$1.00 shipping on either of these items.

FROM THE FACTORY: Problems with some 6502 chips.

I have been informed of two possible problem areas with the 6502 CPU. Some of the early CPU's didn't set the zero flag correctly after register to register transfers, (TAX, TAY, TYA etc). This would make it impossible to run Tiny Basic. All 6502 CPUs could have problems setting the zero flag after decimal addition when the answer equalled zero. Test your CPU with a simple program to see if you have these problems. The decimal addition problem can be gotten around by an "OR" immediate with "00" after the operation which would then set the zero flag correctly. The only method of solving the register transfer not setting zero flag would be to install a new CPU. (You would then pick up the "ROR" rotate right instruction in the process).

Copying KIM cassette tapes:

If you've tried copying KIM tapes from cassette to cassette then you already know that the copies will not be read correctly by KIM. The fix? Simply tie a .02 uf capacitor to ground from the junction of R6 and R34. Now make the new master tape. Copies from this new master should be read correctly by KIM.

KIM-2 Memory expansion:

If you wish your KIM-2 (4K) memory module to reside in the 0400-13FF position already decoded by KIM, then read on: Wire - or the KIM K1, K2, K3, K4 decoder outputs together, add a 3.3K pull-up resistor to +5 volts and tie these four lines to the address line 12 input on the KIM-2, set all the on-board DIP switches to the "off" position, and you're all set!

INTRODUCTION TO KIM-1 ARCHITECTURE

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This is intended to be a beginner's guide to the way KIM-1 is put together. It's mostly a hardware description with (hopefully) explanatory notes.

Because every KIM-1 owner has three fat manuals on his system, complete with detailed drawings, I'll try to save space here by referring to these manuals wherever possible.

The Address and Data Busses.

Let's start with page 24 of the KIM-1 User Manual (KIM-1 Block Diagram, Figure 3.1). We're going to concentrate on those two pipes on the left: the Address and Data Busses.

Every microsecond, the 6502 microprocessor sends out an address over the sixteen lines of the address bus. Sixteen lines are enough to address any of the 65,536 memory locations that could be fitted to KIM-1 (you only have 3,328 active addresses in the basic unit). In addition, there are a couple of other lines that accompany this bus: a Read/Write line (R/W) to tell whether the microprocessor wants to read or write memory; and a timing line, $\phi 2$ (phi, pronounced fy, two; it's confusing on the diagram because the phi looks like a zero).

The address bus goes to all memories. The idea is that when an address is generated, one memory only (whether RAM, ROM, I/O or Timer) suddenly says, 'that's me!' and connects to the data bus. If the R/W line says, 'read', the memory concerned places its data onto the bus; if 'write', the memory takes the data from the bus (placed there by the microprocessor) and stores it. For every address, only one memory unit responds; the rest stay silent.

This points out a fundamental difference between the address and data busses. The address bus goes one way only; from the processor to the memory. But the data bus information flows both ways.

This calls for a special kind of circuitry to connect to the data bus, called 'tri-state'. Every device on the bus might be (1) sending; (2) receiving; or, (3) ignoring the bus. (That isn't exactly how tri-state is defined, but it's a good way to remember it).

LOOKING FOR PROMS??? I just picked up four 825129 bipolar 256x4 proms to make SUPERTAPE and other such used software a permanent part of KIM. S.D. SALES CO., P.O. BOX 28810, DALLAS, TEXAS, 75228, also has 5204 EPROMS (512x8, 1 usec.) for \$7.95, 1702A (1 usec. 256x8) for \$6.95, 8797B's for \$1.25, etc. All their parts are guaranteed and they deliver in about a week. Definitely good people! Get their catalog! If you order from this, include 5% for shipping, \$0.75 for orders under \$10.00, and tax if you're in Texas.

—The editor—

Since address bus signals go one way only, it doesn't need to be tri-state circuitry, which simplifies things. However, it could cause you minor problems if you wanted to expand your KIM-1 system so as to have two processors sharing the same memory, or if you wanted to drive a TV display directly from memory. In cases like that, the problem is called DMA (Direct Memory Access) and hints on how to solve it can be found on page 112 of the Hardware Manual.

Turning to page 25 of the KIM-1 User Manual, we can see the Address and Data busses in a little more detail. A little closer examination turns up a problem: the whole address bus doesn't connect to the memory modules. In fact, only 10 bits (numbered AB0 to AB9) out of the 16 are connected. That's only enough to define 1,024 addresses. How can it work?

Well, buried in the control logic block at the upper right is an 'address decoder'. Although figure 3.2 doesn't show the connections, this circuit is looking at address bus lines AB10, AB11, and AB12. Depending on what it sees in this part of the address, it may fire up either of the ROMs (via leads K6 and K7), or the Timer/IO/RAM section of the 6530's (via lead K5), or the 1K RAM (via lead K0). Each memory unit will work only if its respective K lead is energized. So now, each unit is responding to 10+3 or 13 bits of address information.

The address decoder, incidentally, can be seen in more detail on the next page, Figure 3.3, Control and Timing. It's block U4; you can see the three lines of the address bus coming in from the left, and the select signals (K0 through K7) going out at the bottom. Incidentally, outputs K1 through K4 are not used on the basic KIM-1; but they are available to you for expansion purposes. Each lead is capable on controlling 1K (1,024) bytes of memory.

What about the other three bits of the address bus, AB13, AB14, and AB15? KIM-1 ignores them. They are not needed for the basic system, so they're not used.

This leads to an odd feature of the basic KIM-1 system. Since the three high-order bits of the address are ignored, the memory starts repeating itself after reaching 1FFF hex. For example, try storing something in address, say, 0123; then look at the contents of 2123, and 4123, etc. They're all the same location!

This explains something that can be quite troublesome to the beginner. Both the Hardware Manual (page 40) and the Programming Manual (chapter 9, pages 124-146) state that the interrupt and reset vectors are located at hexadecimal addresses FFFA to FFFF. Yet reading the KIM-1 Monitor program listings shows them to be at 1FFA to 1FFF. Very puzzling--until you realize that in the basic KIM, they are the same locations!

It also outlines something you'll need to take into account when you add memory. If you use the 4K decoded for expansion with lines K1 to K4, no special reconfiguration is necessary ... you're staying in the area where the 'duplicated' addresses won't bother you. But to go to addresses at hex 2000 and higher, read Chapter 6 of the KIM-1 User Manual very carefully.

Interrupts, Reset, and the SST

The 6502 has three pins which force it to branch to a given location. They are called RST (reset), NMI (non-maskable interrupt), and IRQ (interrupt request). They all differ in detail, but the manner in which they cause a branch or jump in program execution is similar; we'll discuss them together.

First: when the appropriate input pin is 'kicked', the microprocessor hardware, after doing a couple of odd jobs, digs out the address that it will jump to from a fixed location. This location varies depending on which pin was activated, but it will be in the range FFFA to FFFF hexadecimal (see page 146 of the Programming Manual).

Next step: because of the way the KIM-1 addressing is wired, you may recall that address FFFA is the same as address 1FFA. This is part of ROM (the 6530-002 chip), so that the contents of these vectors are fixed. They point at programs to handle each activity.

Let's summarize what we have so far in a table:

Pin	Address of Vector Hardware	Contents KIM-1 (Vector)	What you'll find at the vector location
NMI	FFFA-FFFB	1FFA-1FFB	1C1C Program NMIT (Jump indirect)
RST	FFFC-FFFD	1FFC-1FFD	1C22 Prgm RST (A reset program)
IRQ	FFFE-FFFF	1FFE-1FFF	1C1F Program IRQT (Jump indirect)

So the branches we take are completely predefined for us by the Monitor program. In the case of Reset, the system will reset the stack pointer and then proceed to the main monitor program.

But the other two are different. Programs NMIT and IRQT, to which the two respective vectors point, are nothing more than indirect jumps. And the address to which you will jump, in both cases, is stored in RAM; so you can change these addresses to make the two interrupts branch anywhere you want. (Normally, you'll want the address of monitor program SAVE, at 1C00, stored in both vectors).

So there are two kinds of vectors: the hardware vectors at 1FFA to 1FFF which you can't touch since they are in ROM; and the software vectors at 17FA to 17FF which you must set up each time you turn on the system. (Oddly enough, the software vectors include a Reset vector that isn't used).

It's good practice, every time you power up, to key in:

AD 1 7 F A DA 0 0 + 1 C + 0 0 + 1 C + 0 0 + 1 C AD

setting the vectors and thus enabling the ST key and SST switch.

Now let's take a little excursion into software.

When you push the GO button (or hit the G key if you're lucky enough to have teletype), the Monitor does a few last things before it gives up control to your program. Refer to page 39 of the KIM User Manual (Special Memory Addresses). You'll see that locations 00F1 to 00F5 are associated with various registers of the microprocessor.

When you push the GO button, the Monitor digs out these locations and puts them in the microprocessor registers. (You can read the program that does it at locations 1DC8 to 1E87 - it's quite clever).

This means something quite important to the programmer who's doing testing. You can set the initial values of any of the registers before you run - by storing the appropriate values in F1 to F5.

Note that the Monitor does all this. As far as the microprocessor is concerned, these locations have no special status; they are no different from any other part of memory. If a program puts something in the accumulator, the contents of F3 don't change, and vice versa.

Now, we've talked about what happens when your program starts. What happens when it stops? It would be handy (for debugging and other reasons) if the registers could be dumped out to the same locations (F1 to F5).

Well, program SAVE at location 1C00 does exactly that. So if possible, we should try to terminate a program by having it exit to location SAVE. Here are several ways of doing it:

1. Finish your program with the instruction JSR SAVE1 (20 05 1C). The accumulator will be lost, but the other registers will be saved correctly.
2. Finish your program with a BRK (00) instruction, and be sure your software vector at 17FE-17FF set to the address of SAVE (1C00).
3. To stop your program while it is running, press the ST button; but be sure you have previously set the software vector at 17FA-17FB to the address of SAVE

4. If you have t the SST switch to on, the program will stop at one instruction -- provided you have set the software vector at 17FA-17FB to address SAVE. More about how this happens soon.

How does the SST switch do that, anyway? Let's return to the hardware.

The diagram on page 26 of the KIM User Manual (Control and Timing) contains the basic information, especially in the area of U26 (a NAND gate).

We can see that the SST switch, when operated, will kick the NMI interrupt pin when the following two conditions are satisfied:

- 1) Lead K7 is not energized. In other words, the address bus is not in the range 1C00 to 1FFF;
- 2) The SYNC signal is high, which means the processor is fetching an instruction. (See page 44 of the Hardware Manual).

Put these together, and what do they mean? Just this: that if the SST switch is on, and we fetch an instruction that is not in the Monitor, the NMI interrupt will be signalled. The instruction in progress will be completed. Then, if we have set up our vector correctly, the micro will return to the executive, neatly dumping the registers as it does so. (Pressing GO for the next instruction reloads the dumped values so that the next step continues with exactly the conditions left by the previous one).

This is a really neat mating of hardware with software. The hardware allows the Monitor to run freely; but any other instructions are immediately interrupted, and the Monitor takes over again. The software, on the other hand, stacks away the register contents, and restores them when the GO button is pressed again. Elegant, huh?

Last word on interrupts: if you plan to expand the KIM-1 system, all of these features are available for you to modify. Chapter 6 of the KIM User Manual (Expanding Your System) gives quite a bit of material on this.

Digital Tape Drives for KIM-1

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As I stated in a previous newsletter, I am developing an assembler for KIM, and I planned to use the KIM tape I/O system for source input and object output. However, I have encountered several problems including low reliability, slow speed, and general frustration with the limitations of audio cassette recording. I have instead decided to interface a commercial-quality digital storage device to my system. I have chosen the Mini-Raycorder Model 6409 by Raymond Engineering, Middletown, Ct. This drive uses a miniature version of the standard Phillips cassette, a digital-certified version of the one being used in some newer dictating equipment. The drives cost \$350 in singles, declining to less than \$200 in large quantities. I would be willing to organize a group purchase of the drives to take advantage of quantity pricing. I will distribute my interface hardware and software design, as well as my assembler to anyone participating in the group purchase, for the cost of distribution.

The hardware portion of the interface consists of 4 bits of latched output and 5 bits of input (already available on the basic KIM-1). The drives give the computer full control over tape motion (forward/rewind), and read/write status, and let the computer sense cassette-in-place, tape position (beginning or end), cassette write-protect, and cassette side. The technical specs of the drives are:

Recording mode: bit serial, bi-phase, 800 bits/inch.

Tape speed: 3 in/sec forward, 20 in/sec rewind.

Transfer rate: 2400 bits/sec (300 bytes/sec).

Tape length: 50 feet. Capacity: 60,000 bytes/side (2 sides)

Anyone interested in the group purchase should send me a stamped business-sized self-addressed envelope, and indicate how many drives you wish to purchase.

4712 Northway Dr.
Dallas, TX 75206

You might like to run the following note: "Tired of squinting at the 6500 instruction summary--and mistaking B for 8, among other things? You might like a copy of my large type summary summary, which regroups by usage, and lists mnemonics, hex code and formula for the effect of the command. For a Xerox copy, send a self-addressed stamped envelope with an extra 9c stamp (loose) for one copy or 13c stamp for 2 copies to: Mike Firth/6500

1. The relative branch table has become one of my most useful tools once I figured out how it works. Perhaps a word of explanation was in order.
2. The driver circuit for the Kluge Harp originally presented in October 1975, BITE, consisted of a 7437 (not mentioned in the users notes) arranged as a set-reset flip flop and buffer. The same circuit in the users' notes does nothing more than buffer and could just as well be replaced with the original driver circuit presented on Page 57 of the Kim User Manual. I am, also, not sure about the propriety of incrementing the data direction registers; as opposed to keeping PBDD & PAUD as outputs and incrementing the data registers.
3. There seems to be some confusion regarding the interval timers and how to use them. Mr. Lutz listed the addresses of the "other timer" in the same manner as the Kim Program listings does on Page 3 of the User Manual. This was confusing to me, and I hope to clarify the timers' applications.
4. I should hope that the "User Notes" does not become a software catalog; where the average entry goes something like - "I just developed a program for Chinese checkers, which I'll sell to the members for just \$10.00 plus postage". After reading an issue of "User Notes" I feel a tremendous obligation to write something; whether it be a program or just a letter of appreciation for the wealth of information that the notes contain. I should hope that the other members feel the same and are willing to share their software in the knowledge that the hours they spend developing a program will be repaid many fold by the cumulative contributions of many authors of our group. It's the only way that the "Users Notes" can remain viable.

INTERVAL TIMERS

USING THE INTERVAL TIMER AS AN IRQ INTERRUPT

First read paragraph 1.3.2.1 "Applications for Interrupts" in the Kim Hardware Manual. After reading the above paragraph it becomes easier to imagine the interval timer as a separate entity just like a keyboard, control panel or scanned display. The Timer is used to independently time a certain interval during which a program is operating. The "during which" is important because it allows the program to do other things besides waiting in a delay loop for the interval to time out. This independent operation (non-reliance on delay loops within the program) makes the device particularly valuable. Once the timing interval has elapsed it is necessary for the timer to signal the microprocessor.

This is done with the IRQ interrupt which enters the processor through PB7. If PB7 is set up as an input (0 in PBDD), a low on that pin causes the program to jump to whatever is in the IRQ Vector located at 17FE, 17FF. In other words, say you want to do a program in 0000 to 0100 for a short time then switch to 0300 and do a different program. By loading 0300 in the IRQ Vector and setting the timer this can be accomplished.

TIMER ADDRESSING

As can be seen in the address table, A3 controls whether or not PB7 is enabled as an interrupt line.

If you are not using the interrupt capability of the timer, read or write into 1704 to 1707. As an example, during a loop in a program you may continually check to see if the timer is done using the LDA (1704 to 1707) and the Bit instruction.

If you are using the interrupt capability, use addresses 1700 to 170F. The important thing here to remember is that when reading the time after an interrupt go back to 1704 to 1707 so as not to enable PB7 again until required.

p.6

ADDRESS TABLE

ADDRESS		LEAST SIG. ADD. BITS				TIME DIVISION	USE
6530-001	6530-002	A3	A2	A1	A0		
1704	1744	0	1	0	0	+ 1T	Use these addresses to read or write to the timer when not using interrupt mode on PB7 or when reading after interrupt A3 = 0
1705	1745	0	1	0	1	+ 8T	
1706	1746	0	1	1	0	+ 64T	
1707	1747	0	1	1	1	+ 1024T	
1708	1748	1	0	0	0	-	These addresses are not used with interval timer A2 = 0
1709	1749	1	0	0	1	-	
170A	174A	1	0	1	0	-	
170B	174B	1	0	1	1	-	
170C	174C	1	1	0	0	+ 1T	These addresses are used when the IRQ interrupt capability at PB7 is needed A3 = 1
170D	174D	1	1	0	1	+ 8T	
170E	174E	1	1	1	0	+ 64T	
170F	174F	1	1	1	1	+ 1024T	

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Program to check KIM-1 keyboard condition

The following program will check individual keys for excessive bouncing. If an oxide layer builds on the contact surface depressing a key will cause several "bounces" or on and off conditions which may cause multiple or erroneous entries. The program checks the key every n microseconds and writes either FF for contact open or a different code into page 2 of memory. Thus we get 255 samples of the contact closure which we can easily review by calling the previously described Display routine (set MULT in that routine to 1 for faster scan). Set the word #10 in the keyboard program to 00 to check keys 0 - 6, to 02 to check keys 7 - D or to 04 to check the remaining keys E through PC. You can not check keys ST and RS. The time constant between successive samples is set by the value in word #23. The multiplier value is 4 microseconds times word #23.

00	A9 FF	LDA #FF	Set initial delay
02	8D 07 17	STA 1707	
05	2C 07 17	① BIT 1707	Check timer
08	10 FB	BPL ①	
0A	A9 1E	LDA #1E	Set PB1-PB4 to output
0C	8D 43 17	STA 1743	
0F	A9 xx	LDA xx	xx = 00, 02 or 04 (see text)
11	8D 42 17	STA 1742	
14	A9 80	LDA #80	Set PA0 - PA6 to input
16	8D 41 17	STA 1741	
19	AD 40 17	② LDA 1740	
1C	C9 FF	CHP #FF	Check for key depression
1E	F0 F9	BEQ ②	
20	A2 00	LDX #00	Key has been depressed
22	A0 yy	③ LDX #yy	yy - multiplier 5 - 10
24	88	④ DEY	
25	D0 FD	BNE ④	
27	AD 40 17	LDA 1740	Delay finished
2A	9D 00 02	STA,X	Write on page 2
2D	E8	INX	
2E	D0 F2	BNE ③	Continue with next sample or end
30	00	BRK	Stop

Notes: The reason for not using AK or GETKEY routines in this application is that they are too slow to detect the bouncing. To check e.g. key "A" set word 10 to 02, start running the program at 00 by pressing GO. The display goes blank until you press A. Go then to location 200 and start reviewing contents of the 2-nd page. Each FF means a contact bounce.

EDITOR'S NOTE: I changed the BREAK instruction to a JMP to 1C4F to get the program operational.

This program can detect the bounce of ANY switch by just hooking it up to the proper keyboard access pins on the KIM edge connector.

Display Routine

This routine will display any program showing each successive location and the contents of that location. The routine is fully relocatable. By storing in the 17FA and 17FB locations the starting address of this routine one can use the ST key to start the program. The display can be stopped by pressing RS and continued by pressing ST again. The program starts displaying consecutive locations starting with the location shown in the display by pressing ST. The second program location shown controls the display time. With value 04 it is .4 sec per location.

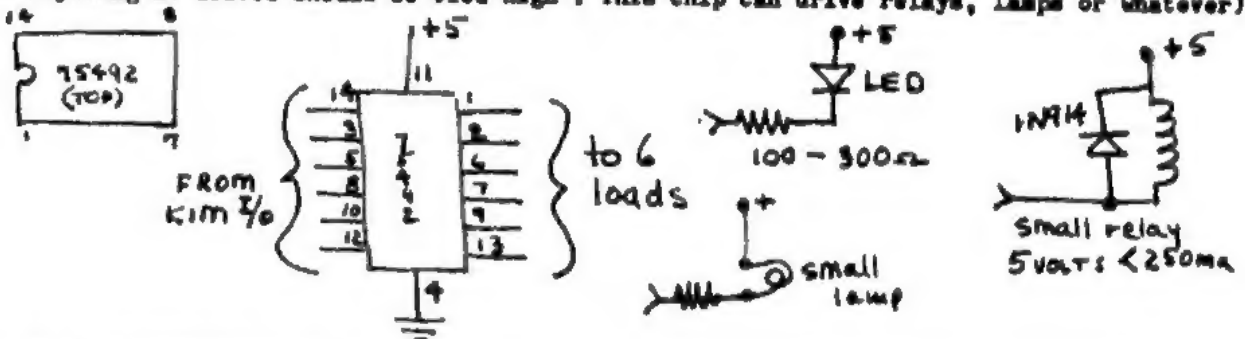
00	A2 04	③	LDX Mult
02	8A	②	TXA
03	48		PHA
04	A9 62		LDA #62 (.1sec/cycle)
06	8D 07 17		STA 1707 Load timer
09	20 19 1F	①	JSR SCANDS Display
0C	2C 07 17		BIT 1707 Check timer
0F	10 FB		BPL ①
11	68		PLA
12	AA		TAX
13	CA		DEX
14	D0 EC		BNE ②
16	E6 FA		INC FA
18	D0 E6		BNE ③
1A	E6 FB		INC FB
1C	D0 E2		BNE ②

e.g. to start displaying at 210: AD,0,2,1,0, ST
if the display starts at 300: AD,1,7,F,A,0,0,+,0,3,AD,30 to desired location, ST...

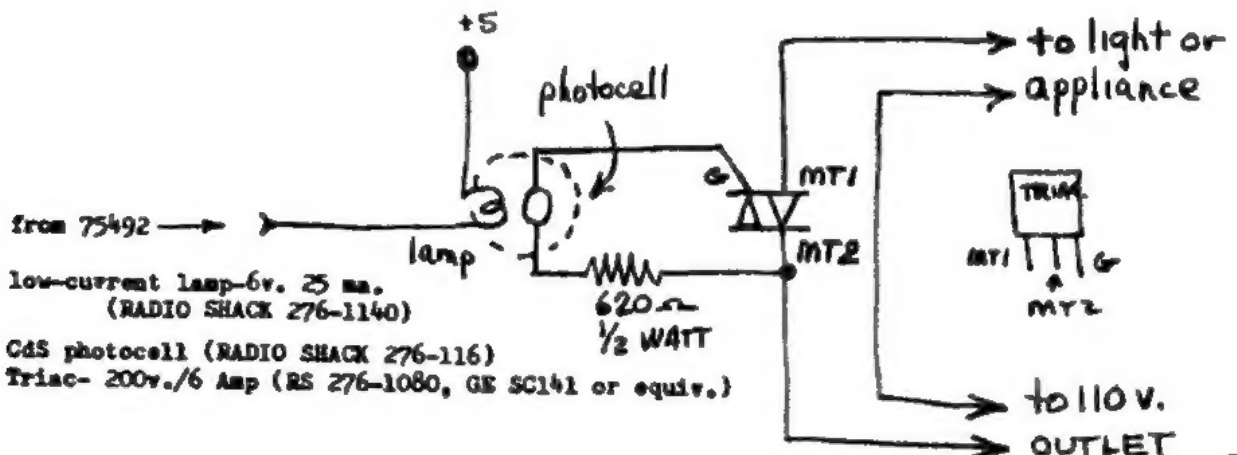
Mr. Levart also enclosed additional details about accessing the keyboard and display which will be included in an upcoming issue — the editor

MORE FROM CASS LEVART

1. KIM LED INTERFACE: The inexpensive (\$0.45 from Alta Electronics) IC #75492 LED DRIVER provides an interface for 6 LED's or lamps (editors note- the 75492 can SINK up to 250 ma. so anything it drives should be tied high). This chip can drive relays, lamps or whatever)



2. KIM AC INTERFACE: This circuit can be used to control lights, appliances, etc. up to 600 watts. Though Sigma light-couplers are available from Allied Electronics, it is easy to make one by wrapping a lamp and a CdS photocell with dark masking tape.



HERE'S ... WAY TO TURN KIM INTO A FREQUENCY COUNTER:

FREQ. COUNT

FROM: Joe Laughter
Univ. of Tennessee
Medical Units
951 Court Ave.
Rm. B23D
Memphis, Tenn., 38163

Counts freq. using input PB0, max rate 20 Khz; counts DATA for 1 sec. to count for 10 sec. load #29 into adr 60. Uses PB7 for int. req. (connect PB7 to INT. REG.)

0000	A9 01		LDA #01	
0002	85 65		STA TMECNT	
0004	F8		SED	
0005	A9 36		LDA # INT LOW	SET INT. VECTOR
0007	8D FE 17		STA FE	
000A	A9 00		LDA # INT HIGH	
000C	8D FF 17		STA 17FF	
000F	58		CLI	
0010	00		BRK	
0011	EA		NO OP	
0012	AD 02 17	<u>CK LOW</u>	LDA PB	CHECK FOR INPUT LOW
0015	29 01		AND #01	
0017	DO F9		BNE CK LOW	
0019	AD 02 17	<u>CK HIGH</u>	LDA PB	CHECK FOR INPUT HIGH
001C	29 01		AND #01	
001E	FO F9		BEQ CK HIGH	
0020	18		CLC	ADD COUNT TO TOTAL
0021	A9 01		LDA #01	
0023	65 F9		ADC F9	
0025	85 F9		STA F9	
0027	A9 00		LDA #00	
0029	65 FA		ADC FA	
002B	85 FA		STA FA	
002D	A9 00		LDA 00	
002F	65 FB		ADC FB	
0031	85 FB		STA FB	
0033	4C 12 00		JMP CK LOW	
0036	48	<u>INT.</u>	PHA	CHECK TIME
0037	A9 90		LDA #90	
0039	8D 04 17		STA 1704	
003C	2C 07 17		BIT 1704	
003F	10 FB		BPL DELAY	
0041	A9 F4		LDA #F4	SET TIMER FOR ANOTHER INT.
0043	8D 0F 17		STA 170F	

0046	C6 65		DNC TME CNT	CHECK RE JING TIME
0048	FO 02		BEQ DISP	IF ZERO DISPLAY COUNTS
004A	68		PLA	
004B	40		RTI	
004C	A9 FF	<u>DISP.</u>	LDA FF	SET DISPLAY LOOP CNT
004E	85 66		STA SCANCT	
0050	20 1F 1F	<u>OUT</u>	JSR SCANDS	OUTPUT DATA
0053	C6 66		DEC SCANCT	DEC. LOOP CNT
0055	DO F9		BNE OUT	REPT. DISPLAY TILL LOOP
0057	A9 00		LDA 00	COUNT IS ZERO
0059	85 F9		STA F9	SET TOTAL COUNTS TO ZERO
005B	85 FA		STA FA	
005D	85 FB		STA FB	
005F	A9 05		LDA 05	RESET 1 <u>SEC.</u> TIMER
0061	85 65		STA TMECNT	
0063	68		PLA	
0064	40		RTI	
0065	05		*DATA (TMECNT)	
0066	FF		*DATA (SCANCT)	

Dear Eric:

Don Box
1250 White Oak Dr.
Cookeville, Tn. 38501

As a fellow KIM-1 fan may I wish you well on the USER NOTES undertaking; they are most useful and interesting. As a small contribution (if anyone is interested) I am enclosing a photo of how I mounted my KIM-1 in a cabinet and provided expansion room for future projects.

One of my interest was driving outside devices and I came up with the following scheme to give up to 16 I/O ports (8-bits ea). The system uses six pins of port B and three pins of port A plus some external hardware. The amount of external hardware required depends upon the number of devices connected but runs about three TTL chips per device plus the hardware driver.

Driver software is in RAM, I used locations 1780 thru 17DB. An input or output to a device requires about 300 microsec if the device is ready to accept or receive data.

Figure 1 shows the hardware driver, figure 2 a typical device interface and figure 3 the software listing. I use an old Model 15 (5-level) teletype and a UART, this interface is shown in figure 4.

I can supply more details if anybody wants if they will send a S.A.S.E.

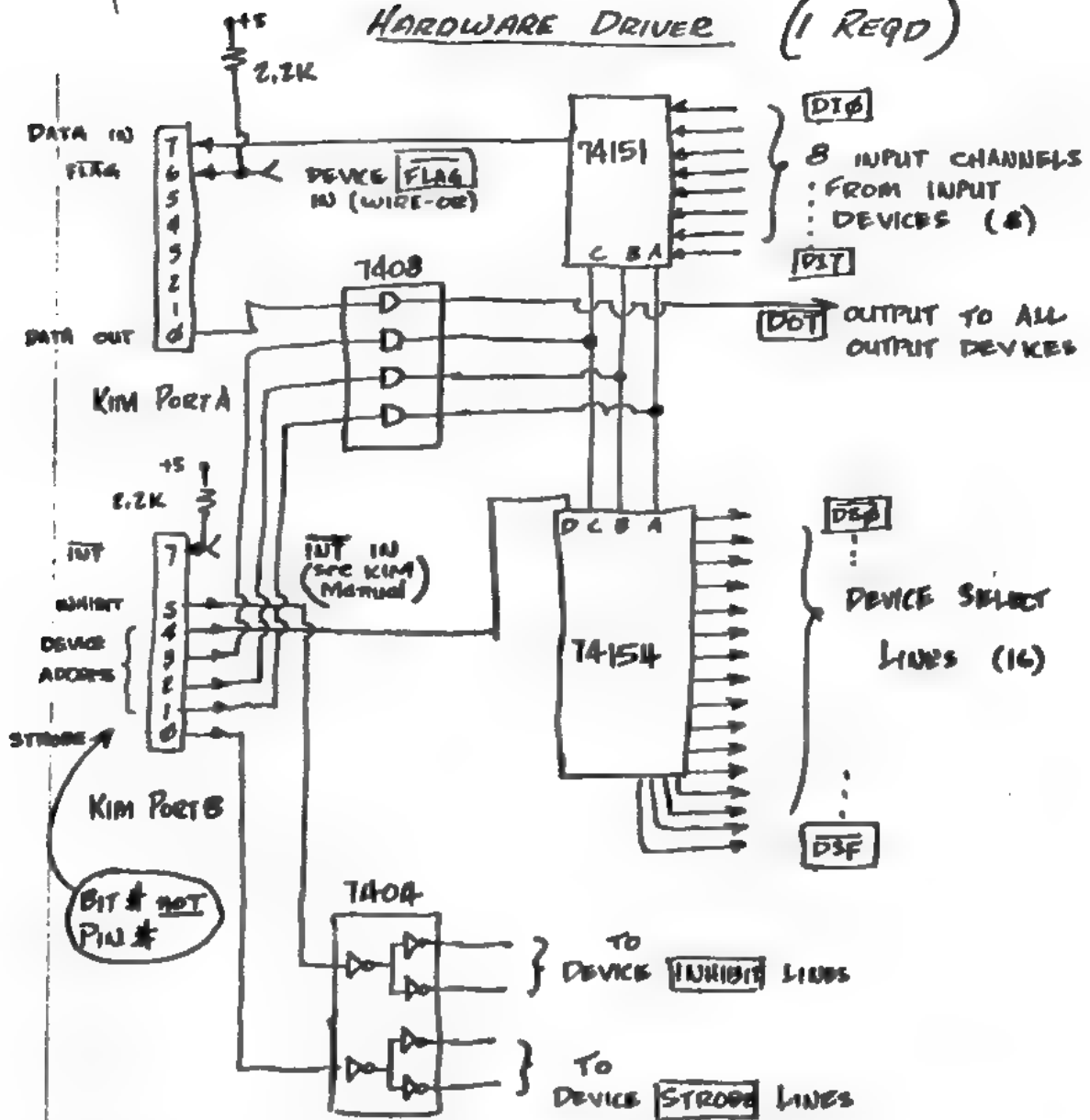
Keep up the good work--

Don Box

p.10

FIGURE 1

HARDWARE DRIVER (1 REQD)



NOTE:

INITIALIZE: LOCATION
 1701 TO HEX '01'
 1703 TO HEX '3F'

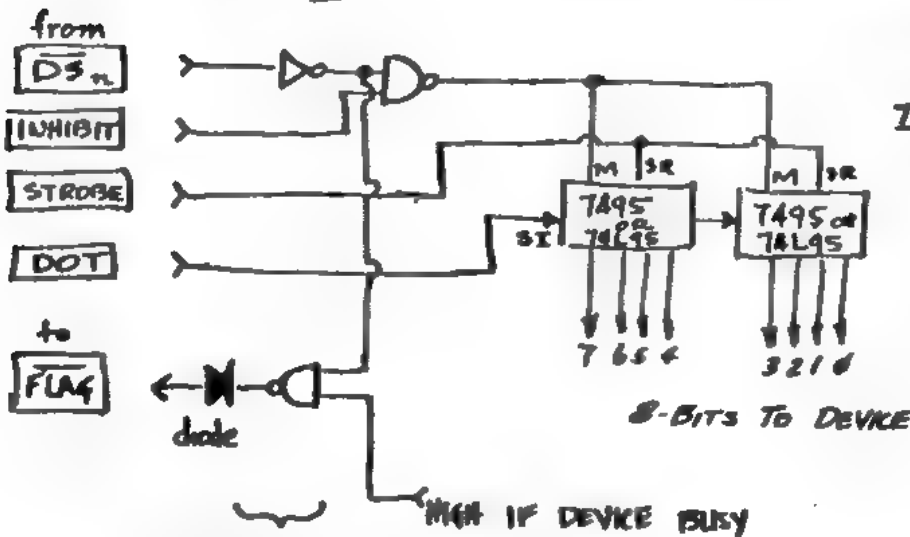


FIGURE 2
TYPICAL DEVICE INTERFACE

TYPICAL OUTPUT INTERFACE

(max. of 8 possible)

from DS_m

INHIBIT

STROBE

to DI_m

FLAG

diode

7495 or 74L95

7495 or 74L95

0 1 2 3 4 5 6 7

8-Bits from Device

HIGH IF DEVICE BUSY

AVAIL..

DEV. LOAD

74-7400 TYPICAL INPUT DEVICE INTERFACE (max. of 8)
Software I/O driver

FIG. 3.

1706	20	CA	17
1783	50	FB	
1785	10	08	
1787	20	04	17
178A	4A		
170B	2C	06	17
178E	30	0D	
1790	EE	02	17
1793	CE	02	17
1796	0B		
1797	00	F1	
1799	0E	02	17
179C	60		
179D	09	06	
179F	30	EF	

17AA	20	CA	17
17AD	50	FB	
17AF	40	00	
17B1	40		
17B2	20	04	17
17B5	60		
17B6	80	00	17
17B9	EE	02	17
17C2	CE	02	17
17BF	4A		
17C0	8B		
17C1	D0	F3	
17C3	8E	02	17
17C6	60		

17CA 8E 02 17
17CD 2C 00 17
17D0 60

1704 BA
1705 09 20
1707 80 02 17
PRA 60

```

; INPUT SUBROUTINE
GETBYTE: JSR CKFLAG      ; SEE IF DEVICE AVAILABLE
          BVC GETBYTE    ; NO WAIT
          LDY #1000       ; SET BIT COUNTER
          JSR INHIBIT     ; INHIBIT DEVICE
RDBIT:    LSR A           ; MOVE OVER
          BIT PAD         ; CHECK BIT
          BMI AONE        ; FOR A 1
NEXT:     INC PBD         ; NOPE --- SHIFT
          DEC PBD         ; VIA STROBE LINE
          DEY            ; COUNT
          BNE RDBIT      ; DO MORE
          STX PBD        ; ENABLE DEVICE
          RTS           ; AND RETURN
AONE:     ORA #1000       ; MAKE BIT 7 A ONE
          BMI NEXT       ; AND STROBE

```

```

; OUTPUT SUBROUTINE
PUTBYTE: JSR CKFLAG      ; SEE IF BUSY
          BVC PUTBYTE     ; YES, WAIT
          LOY $$08        ; BIT COUNTER
          PHA             ; SAVE BYTE
          JSR INHIBIT     ; INHIBIT DEVS
          PLA             ; RESTORE BYTE
BURP:     STA PAD         ; SET OUT BIT
          INC PBD         ; STROBE FOR
          DEC PBD         ; SHIFT
          LSR A           ; MOVE OVER
          DEY             ; COUNT
          BNE BURP        ; DO MORE
          STX PBD         ; NOPE, ENABLE
          RTS            ; AND RETURN

```

```

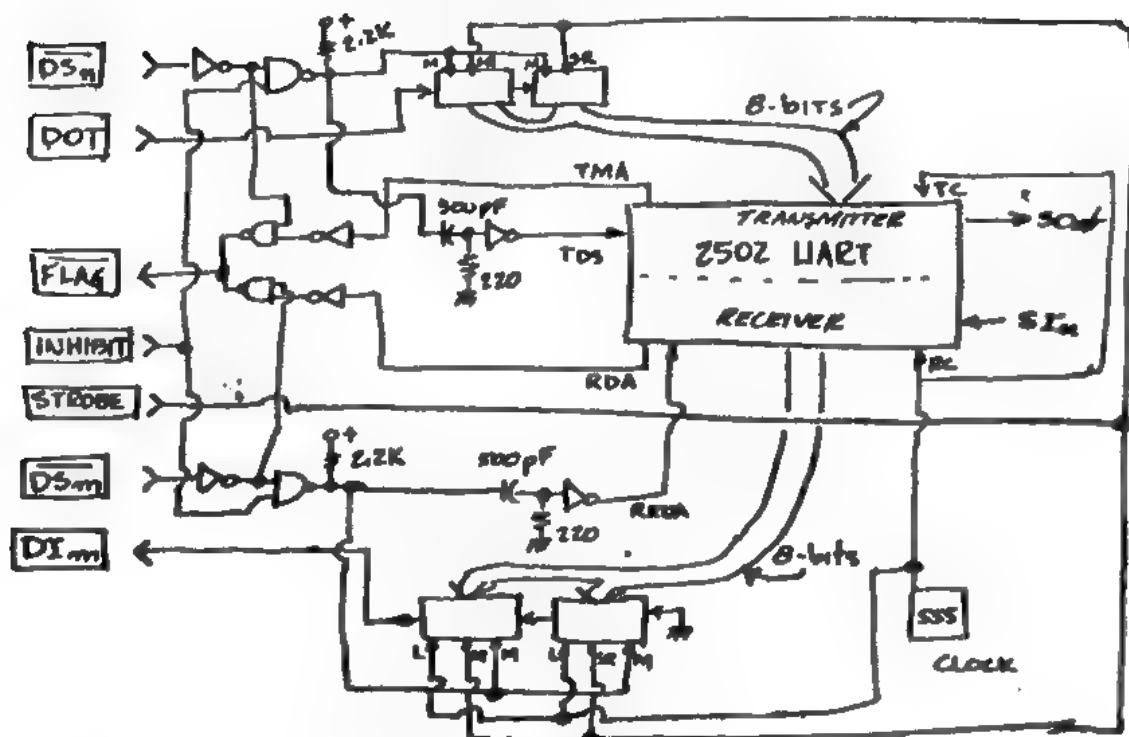
; MISC SUBROUTINES
CKFLAG: STX PBD      ; SELECT DEVKE
        BIT PAD      ; FLAG BIT 6
        RTS          ; RETURN V-BIT

```

```
INHIBIT: TXA          ;GET DEV. ADDR.
          ORA $200     ;SET INHIBIT BIT
          STA PBO      ;INHIBIT DEVICE
          RTS          ;RETURN
```


FIGURE 4

UART INTERFACE



7404 1-REQD

7403 1-REQD

7495
or
74195 4-REQD

2502 1-REQD
UART

555 1-REQD
555 TIMER
As Astable
@ 16X baud rate

to Output a byte
LDA byte
AZ #100 LDX DEV
20 AA 17 JSR PUTBYTE

to input a byte
LDX DEV
AZ #100
20 80 17 JSR GETBYTE
STA byte

END

HAVE YOU BEEN HAVING PROBLEMS OPERATING YOUR KIM-1 CASSETTE SYSTEM RELIABLY ON AC POWER? THE MAIN PROBLEM MAY BE DUE TO AN UNREGULATED POWER SUPPLY.

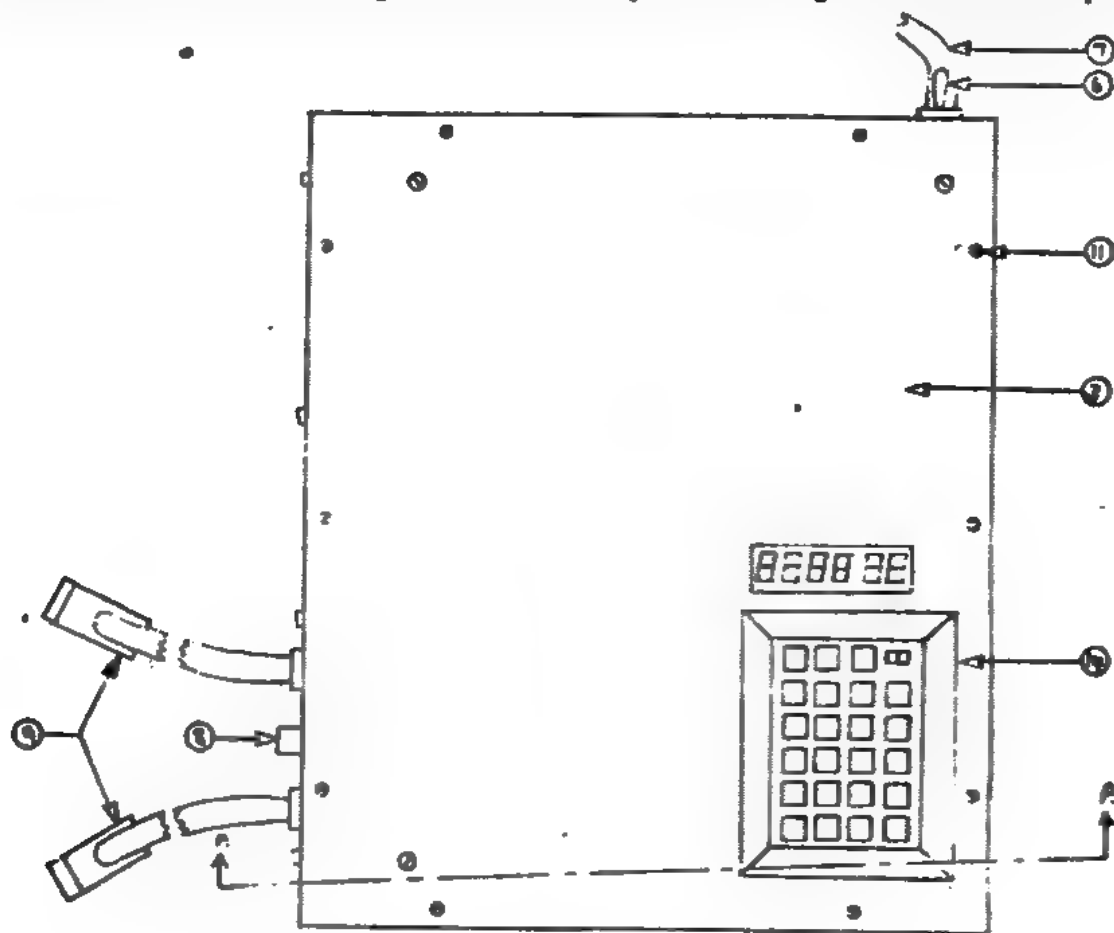
SINCE ACQUIRING MY KIM-1 SYSTEM I HAVE HAD A PROBLEM OPERATING MY TWO AUDIO CASSETTE UNITS WITH AC POWER. THE PROBLEM SYMPTOM WAS NOT BEING ABLE TO ACQUIRE SYNCHRONIZATION. HOWEVER THEY OPERATED FINE ON BATTERIES. EXAMINING THE CASSETTE OUTPUTS, I FOUND A HIGH AC RIPPLE AND POOR VOLTAGE REGULATION CAUSED BY UNREGULATED POWER SUPPLIES.

MY SOLUTION WAS TO DESIGN AND BUILD SEPARATE REGULATED POWER SUPPLIES FOR EACH UNIT (6.0V AND 7.5V). THIS HAS YIELDED VERY SATISFACTORY RESULTS. SEVERAL TIMES THE UNITS HAVE READ 128-256 BYTE DATA PAGES WITHOUT ERROR.

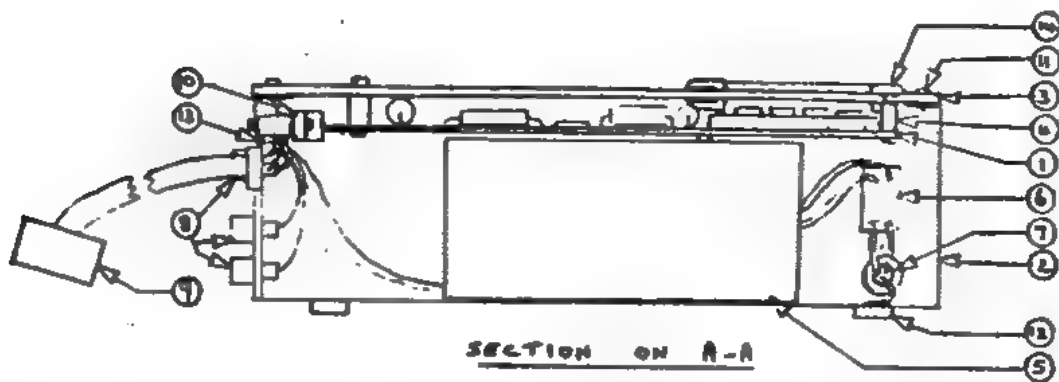
RECENTLY, I SUCCESSFULLY READ A COUPLE OF 256 BYTE PAGES USING JIM BUTTERFIELD'S SUPERTAPE. I AM LOOKING FORWARD TO ITS TIME AND TAPE SAVINGS.

CHUCK BALSER
IN OVERBROOK CIRCLE
NEW HARTFORD, N.Y. 13413

I used a standard Bud chassis, turned upside down, with a clear plastic top. The latter I painted black on the underside, except for the display area and the keyboard cutout. I had originally planned to project the keyboard through the opening, but had too hard a time trying to desolder it from the circuit board. The present arrangement is quite satisfactory and the circuit board has complete protection. The power supply is at one end, so there is plenty of room for expansion circuitry inside. I use wirewrap backplane sockets to bring out the applications connections as DIP plugs are male (live pins) and fragile. I use wirewrap extensively.



TOP VIEW



SECTION ON A-A

- | | |
|-----------------------------|--------------------------------------|
| 1) KIM-1 | 8) Phone jacks for tape recorder (3) |
| 2) 10"x12"x3" Alum. chassis | 9) Wirewrap backplane connectors (2) |
| 3) 10"x12"x1/8" plexiglass | for applications |
| 4) 7/16" long standoffs (5) | 10) Applications connector |
| 5) Power supply | 11) Sheet metal screws (10) |
| 6) Power switch | 12) Rubber bumpers (4) |
| 7) Line cord | 13) System ground point |
| | 14) Rubber edge moulding |

KIM-1 ASSEMBLY

Program MULTIA (second, revised version). Does binary multiplication of two 8-bit numbers that have been stored (before the JSR to MULTIA) in 00E3 and 00E4 and are destroyed by the operation of the subroutine. The hi 8 bits of the product are stored in 00E0 and the low 8 bits in 00E1; the subroutine initially zeroes these locations, and also 00E2. Operations use LSRs on the multiplier in 00E4 to move up to 8 bits in sequence into the carry flag. If the carry is set, the multiplicand (in 00E2 and 00E3) is double-precision added to the product locations. If bits remain in the multiplier (00E4 not zero), the multiplicand is shifted left in the 16 bits of 00E2-00E3; otherwise the subroutine exits. Program length 36 bytes. Maximum product (FF X FF) is FE01 or decimal 65025, with execution time about 380 microseconds. Time declines to 240 microseconds for 80 X 80, 160 microseconds for 10 X 10, 70 microseconds for 01 X 01, 40 microseconds for 00 X 00.

NOTE: This subroutine assumes that the processor is in the binary (not the decimal mode)! It should not be necessary for subroutines to protect themselves (by a CLD) from this problem!

000A	A9	00	(zeroes locations 00E0 to 00E2)
	85	E2	
	85	E1	
	85	E0	
0012	46	E4	(LSR 00E4, lowest bit into carry)
0014	90	0D	(if carry clear, skip the addition)(go to 0023)
0016	18		(CLC starts double-precision add)
	A5	E1	
	65	E3	(running totals stored in 00E0-00E1)
	85	E1	
001D	A5	E0	
	65	E2	
	85	E0	
0023	A5	E4	(LDA of 00E4, zero flag set if zero)
	F0	06	(exit to 002D if zero)
0027	06	E3	(ASL shifts highest bit of 00E3 into carry,
	26	E2	ROL shifts carry into lowest bit of 00E2)
002B	90	E5	(carry is always clear, so back to 0012)
002D	60		(RTS exit)

SUBROUTINE DIVIDA. This software gives the quotient, to 16-bit or better precision, from division of any hex number from 0001 to FFFF by any hex number from 01 to FF. It uses the 10 lowest locations in zero-page. The quotient appears in the lowest 5, with a fixed decimal implied between 01 and 02. The range of quotients is from \$ 0000.010101 (from division of 0001/FF) to \$ FFFF.000000 (from division of FFFF/01). Quotient locations are initially zeroed by a JSR to SUBROUTINE ZEROER, which must also be in memory and is coded separately for use in other programs. Before the JSR DIVIDA, 4 locations must be filled by the calling program. The dividend high byte is set in 06, the low byte in 07, and the divisor in 08. The "precision byte", with a value from 01 to 05, is set in location 09; it is not altered by the program, but the other 3 bytes usually are. The purpose of the precision byte is to allow the user to control the number of quotient locations to be calculated by DIVIDA. A value of 01 causes exit after the proper quotient value in location 00 (which may be 00) has been calculated. A value of 02 limits the calculation to quotient locations 00 and 01, and gives "integer arithmetic". A value of 03 allows only one location to the right of the implied decimal, etc.. The chief use is to shorten the execution time, which can approach 2000 microseconds at a precision of 05. However, DIVIDA always exits when the calculated remainder is zero, since calculation of higher-precision locations is then unnecessary. No "rounding-off" operations are included. E.g., the quotient of FEFE/FF is 00FF.FD0000 at a precision of 03, although it should be 00FF.FE since the quotient is 00FF.FDFDFD at a precision of 05.

DIVIDA exits in less than 150 microseconds if the dividend is 0000. It provides no protection against a divisor of 00, so the calling program should guard against this! ~~eg~~ A guard could be inserted in DIVIDA, but I feel it is better for the calling program ^{what should be done (to decide)} if such an error occurs.

Operation of DIVIDA involves addition of a shifting single-bit "Bit-Byte" in location 05, to the quotient location controlled by the X-register, whenever a positive remainder is obtained. The X-register is not protected by DIVIDA, so it is better to use Y-indexed loops in the calling program (that otherwise will have to store and restore the X value). The final remainder is in location 06 when DIVIDA exits. The divisor value is not altered if it is \$ 80 or more; otherwise it is left-shifted by DIVIDA.

DIVIDA is very long (70 bytes, or 78 if one includes ZEROER; if the zeroing operation were made an integral part of DIVIDA the length would be 74 bytes and execution a shade faster). It is also slow compared to hardware arithmetic, but relatively inexpensive. It is meant to handle data, that are never very precise, and not the kind of complex math for which calculators are designed. Since the ROR instruction is not used, it will run in any 6502 system.

Much of the length of DIVIDA is caused by special logic designed to reduce the execution time---a deliberate trade-off of more program bytes for a lower average time, that has the effect of prolonging the time of divisions where no early exit is possible.

Coding for SUBROUTINE ZEROER.

```
0200  A9 00    (LDA # 00)
      95 FF    (STA zero-page, X)
0204  CA      (DEX)
      D0 FB    (BNE, if # 0 back to 0202)
0207  60      (RTS)
```

Coding for SUBROUTINE DIVIDA. (Note that 3 locations are unused between the end of ZEROER and the start of DIVIDA. This is to allow users (if the subroutines are in RAM) to insert 3 instructions following the LDA divisor instruction at 0213. If the divisor is 00, DIVIDA is ~~knapped~~ ^{knapped} wrong. ~~and~~ ^{and} ~~the~~ ^{the} instructions DO 01 00 substitute for this a BREAK to 1C00. If something more complex is needed, the 3 instructions can be a JMP or JSR to a longer sequence of instructions.)

```
020B  A2 06    (LDX # 06)
      20 00 02 (JSR ZEROER, to zero 0000 to 0005)

0210  38      (SEC)
      26 05    (ROL sets Bit-Byte to 01 and clears carry)
0213  A5 08    (LDA divisor byte)
      30 05    (BMI, if Bit 7 = 1, skip to 021C)
0217  26 05    (ROL Bit-Byte)
      0A      (ASL, left-shift divisor in accumulator)
021A  D0 F9    (BNE, if # 0, back to BMI at 0215)
      85 08    (STA bit-pattern LXXX XXXX into divisor loc.)

021E  A5 06    (LDA dividend-hi)
      B0 0F    (BCS, if carry set go to subtraction at 0231)
022E  D0 09    (BNE, if # 0, go to CMP at 022D)
      A5 07    (LDA dividend-lo)
0226  F0 28    (BEQ, dividend = 0 so exit to 0250)
      85 06    (STA dividend-lo into dividend-hi location)
022A  86 07    (STX zeroes dividend-lo)
      E8      (INX to shift to next higher quotient loc.)

022D  C5 08    (CMP dividend-hi with divisor)
      90 0B    (BCC, divisor too large, bypass to 023C)
0231  B5 08    (SBC, subtract divisor from dividend-hi)
      85 06    (STA remainder into dividend-hi)
0235  18      (CLC for addition)
      B5 00    (LDA zero-page,X the proper quotient byte)
0238  65 05    (ADC the Bit-Byte)
      95 00    (STA zero-page,X back into quotient loc.)
```


P 17

(complete) / coding for DIVIDA)

023C	46	05	(LSR the Bit-Byte)
	D0	09	(BNE, if # 0, bypass resetting)
0240	E8		(INX to shift to next higher quotient loc.)
	E4	09	(CPX to precision-byte)
0243	F0	08	(BEQ, if equal exit to 0250)
	A9	80	(LDA # 80 to reset)
0247	85	05	(STA into 05 resets Bit-Byte)
0249	06	07	(ASL dividend-lo starts dividend left-shift)
	26	06	(ROL dividend-hi completes the shift)
024D	4C	1E 02	(JMP to 021E for next test sequence)
0250	60		(RTS)

Execution time depends both on the number of quotient locations to be filled and on the number of 1-bits to be inserted. Thus, PPPF/01 runs slowly because it requires insertion of 16 1-bits into 2 locations. The "hi/lo exchange" operation at 0228 speeds up many operations with a dividend of 00XX. In general, higher speed will require sacrificing precision, and a precision-byte of 04 will be adequate. My reason for limiting the dividend to 16 bits and divisor to 8 bits was that data more precise than 1 part in 256 will be rare, so that most data will be single-byte, and data sets with more than 256 items will be uncommon. Calculation of the average of 255 one-byte data items is within the capacity of DIVIDA. When there are more, they can be divided into subsets of 255 or fewer, the averages for all subsets added, and the average of the set of subsets calculated. We are now in the time range of seconds! With more bits, it would be minutes. People who need arithmetic speed had better get a 16-bit microprocessor (or better still, shell out for hardware multiply-divide).

Those who want integer arithmetic operations will do better using a dividend of type XX00 and precision-bytes of 01. However, similar effects can usually be obtained more quickly and easily by other logic, not division. The number of possible ways of doing division is incredibly large, but I will be surprised if an operation like that of DIVIDA can be done with many fewer bytes or much higher speed, although using the ROR instruction might help.

HERE'S A RELATIVE BRANCH CALCULATOR ETC. FROM: Ted Beach K4MKX, 5112 Williamsburg Blvd., Arlington, Va. 22207

I am enclosing for your perusal two programs I find to be very helpful in writing assembly language programs on KIM.

Also, may I say that the Users Notes has already proven worth the money - even after only two issues. Mr. Butterfield is fantastic, and I really dig his SUPERTAPE - worth the money all by itself! You can add the Morelco 150 Carrycorder to the list of "always works" machines. Mine is about 15 years old and I don't think they are imported any longer, but it is a real good machine.

In addition to the two programs, I have a simple hardware modification which allows the KIM to be started in the monitor mode - a power on reset function which is very easy to add. I built the whole thing on a small piece of perf-board which dangles from the expansion connector.

One other hint I have found helpful when loading multiple section programs (like WUMPOS) is to assign the same ID number, and before loading the first section into KIM, make the following entries:

00EF 73
00FO 18

This is the program counter location, and after getting the first section of the program into KIM, leave the recorder running and punch PC, GO real fast and you're ready for the next section. Also, if you should happen to drop a bit and get an error exit (FFFF 1C), pressing PC gets you back to the tape-read program in a hurry without having to key in 1873.

As there you have it, Eric. Do keep up the good work and let me know if there is anything I can do to help you with the User Notes. I am at present teaching KIM to talk BAUDOT so I can use a cheap 5-level printer soon. Will keep you informed. It looks like a one-page program right now. Next comes Morse, etc., followed by a home-brew ASCII keyboard and more memory.

Branch Calculator - Ted Beach - KIM-1

0200 D8	ENTER	CLD	0242 20 6A 1F	JSR	GETKEY
0201 38	CO.PUT	SEC	0245 C9 15	CMP	#\$15
0202 A5 FA		LDA POINTL	0247 10 E3	BPL	BEGIN
0204 E5 00		SBC SAV	0249 C9 12	CMP	#\$12
0206 85 F9		STA INH	024B F0 18	BEQ	SAVE
0208 A5 FB		LDA POINTH	024D C9 14	CMP	#\$14
020A E5 01		SBC SAV+1	024F F0 B0	BEQ	COMPUT
020C 30 0E		B-I NEG	0251 C9 10	CMP	#\$10
020E C9 00		CMP #0	0253 10 D7	BPL	BEGIN
0210 D0 14		BNE ERROR	0255 0A	DATA	ASL A
0212 A5 F9	HIOK	LDA INH	0256 0A	ASL A	
0214 C9 80		CMP #\$80	0257 0A	ASL A	
0216 10 0E		BPL ERROR	0258 0A	ASL A	
0218 A9 00	OUT	LDA #0	0259 A2 04	LDX #\$04	
021A F0 0C		BEQ DISP	025B 0A	DATAL	ASL A
021C C9 FF	NEO	CMP #\$FF	025C 26 FA	ROL	POINTL
021E D0 06		BNE ERROR	025E 26 FB	ROL	POINTH
0220 A5 F9		LDA INH	0260 CA	DEX	
0222 C9 80		CMP #\$80	0261 D0 F8	BNE	DATAL
0224 10 F2		BPL OUT	0263 F0 C7	BEQ	BEGIN
0226 A9 FF	ERROR	LDA #\$FF	0265 A2 01	SAVE	LDX #\$01
0228 85 FA	DISP	STA POINTL	0267 B5 FA	SAVE1	LDA POINTL,X
022A 85 FB		STA POINTH	0269 95 00		STA SAV,X
022C 20 1F 1F	BEGIN	JSR SCANDS	026B CA	DEX	
022F D0 FB		BNE BEGIN	026C 10 F9	BPL	SAVE1
0231 A9 01	BEGIN1	LDA #\$01	026E A2 01	LDX #\$01	
0233 2C 40 17		BIT SAD	0270 B6 00	ADD2	INC SAV
0236 F0 F4		BEQ BEGIN	0272 D0 02	BNE	NEXT
0238 20 1F 1F		JSR SCANDS	0274 B6 01	INC	SAV+1
023B F0 F4		BEQ BEGIN1	0276 CA	NEXT	DEX
023D 20 1F 1F		JSR SCANDS	0277 10 F7	BPL	ADD2
0240 F0 EF		BEQ BEGIN1	0279 30 B1	BMI	BEGIN
			027B		(LAST+1)

Two page zero locations used: SAV = 0000
SAV+1 = 0001

You can enter the program at any point, however 022C is the best place.

To use the program, enter the address of the branch instruction via the keyboard and press + for enter data. Next enter the destination address of the branch via the keyboard and press PC for perform calculation. The display will show 0000 IX, where IX is the offset value to enter in your program. If you see FFFF IX, the branch is out of range.

The addresses to use in the calculation are the actual line addresses of the instructions, not the actual location of the start of the branch.

For example, to compute the offset for the branch instruction at address 0224 in the program, enter 0 2 1 4 +. The address of the destination (OUT) is entered next : 0 2 1 8 PC and you will see displayed: 0000 F2.

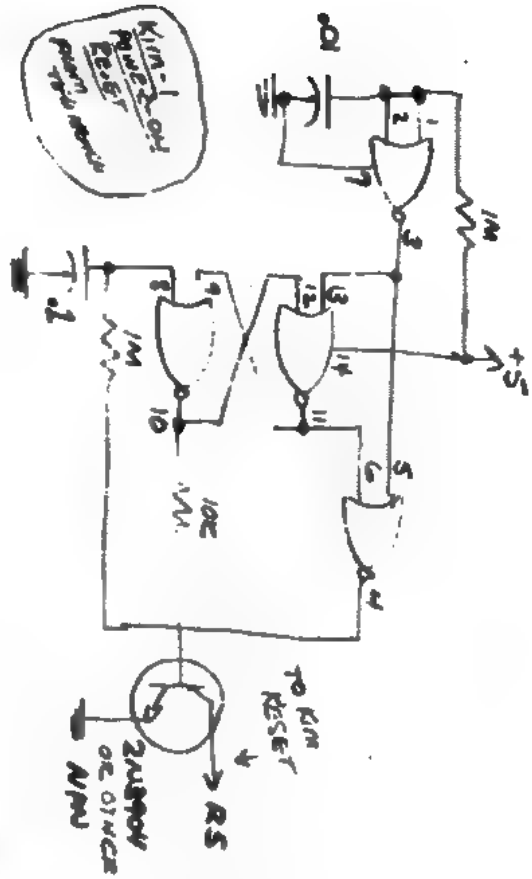
If you make a mistake entering an address, just re-enter it, like you do when using the KIM-1 monitor program.

The program is completely re-locatable as there are no jumps other than to KIM subroutines.

(The rather inefficient coding at SAVE happened when I was fooling around with indexed addressing and could be simplified to: LDA POINTL, STA SAV, LDA POINTH, STA SAV+1 - ~~same~~ bytes instead of ~~two~~ Also, the technique used at OUT - 0218 - is handy for a two-byte jump or a branch-always instruction like the 6800 type. Do something to the accumulator, knowing which flags will be affected, and then follow with a branch - real handy on occasions.)

1780 = SAH
1781 = SAL
1782 = EAL+1
1783 = MIN

1784	D8		CLC	
1785	36		SEC	
1786	AD 82 17		LDA	HAL-1
1789	ED 81 17		SBC	SAL
178C	AA		TAX	
178D	AD 80 17		LDA	SAH
1790	85 FB		STA	POINTH
1792	8D AE 17		STA	17AE
1795	8D B1 17		STA	17B1
1798	AD 81 17		LDA	SAL
179B	85 FA		STA	POINTL
179D	8D AD 17		STA	17AD
17A0	16		CLC	
17A1	6D 83 17		ADC	NUM
17A4	8D B0 17		STA	17B0
17A7	90 03		BCC	DOIT
17A9	EE B1 17		INC	17B1
17AB	BD 00 00	DOIT	LDA	SA,X
17AF	9D 00 00		STA	SA+NUM,X
17B2	CA		DEX	
17B3	EO FF		CPX	#FF
17B5	DO F5		BNE	DOIT
17B7	4C WF 16		JMP	START(return to KIM)
17BA				(Last-1)



This program allows one to move a group of data up in memory so as to be able to insert extra bytes (1 to 255) in a program. The address of the first byte to be moved is entered in 1780, 1781. The lower address of the last byte-1 in the program is put in 1782. The number of bytes you wish to insert in the program is put in 1783. Press + and GO and it's done. The program exits to KIM with the required starting address displayed so you can write in your data immediately by pressing DA.

As an example, I wanted to add two bytes to the Moon Lander program so that when in the FUEL mode, the display would show \$ F000 XX. This required an ORA #3F0 instruction just after SHOFL (0063). The address of the first byte to be moved is 0065, which goes in 1780 and 1781. The last byte to be moved (lower address only) is C5 which is entered in 1782. I need to add two bytes, so 02 goes in 1783. Press + and C0 and you'll see 0065 A6 displayed. Push DA, 09 + F0 and you've done it.

Now you'll have to change any branches which cross the patch by 02, and you'll have to add 02 to all addresses which follow the patch, as well as change the jump addresses... no real problem, and it sure beats re-entering all that data by hand!

From the Editor - Mr. Beach's relative branch calculator is really slick! I'm sure that all of us will be able to save plenty of time. An absolute branch can also be achieved with 3 bytes by CLC BCC etc.

The program patcher is a good starting point for a general purpose "move bytes" routine that could move bytes up or down in memory. It should work with programs of ANY length and may have to cross page boundaries. Be aware, though, that if the move routine is moving bytes to lower addresses, it will have to start pulling bytes down from the bottom end working up to the top end and vice versa for moving bytes upward in memory. Teds program patcher will not cross page boundaries and can only move bytes up in memory.

And some more ideas for utility programs: A couple of articles in the Feb. issue of Kilo-baud really got the grey cells into a flurry of activity. The first article "Chasing Those Naughty Bits" (John Molnar) described an interesting "walking-bit" memory test program for a 6800 that could very easily be rewritten for the 6502. John also introduced the readers to the idea of a "SYSTEM EXERCISER" program which would test ALL machine instructions capable of being executed by the CPU. Another idea for the 6500 system. A SYSTEM EXERCISER and memory test program should be included with every system to instill confidence in the new system owner.

Kilobaud #2 also had an article of interest to those of us with termin

The article "Cut programming time with this extraordinary Program" (Mark Borgenson P.104) described a hex loader routine to make loading programs go alot smoother. The Motorola "Mikbug" is similar to the Kim Monitor in that as you load the memory, via terminal, each memory location is printed out along with the contents of that location. To access the next location, you punch the keyboard again and go through the whole procedure again and again. Borgenson's alternative, (written for 6800 again) allows you to type in as many bytes as will fit on a line (whatever your terminal line length is). When going to a new line, the computer could indicate the next available address to be loaded. Provisions were included to allow backspacing the memory pointer to allow for error corrections.

Converting programs from the 6800 to the 6502 is relatively straight forward once you are familiar with the program operation.

Understanding the 6800 instruction set is again straightforward once you know the 6502.

Several new books came out recently which, although written about the 6800, could be useful to our purposes. I have not read either of them yet and would appreciate a review of these publications by someone who has read them.

"Scelbi "6800" Software Gourmet Guide" (\$9.95)

Scelbi Computer Consulting Inc.

1322 Rear Boston Post Road

Milford, Ct. 06460

Tel. 203-874-1573

"6800 Programming For Logic Design" \$7.50

#5001

Adam Osborne

Remember the Assembler - Text Editor that was mentioned on page 1 issue #17. Well, after receiving several letters indicating that the assembler/text-editor had not yet been delivered. I decided to find out what the problem was. I talked with David Snow, president of Micro-Software Specialists. He stated that they were running into difficulties getting the assembler together and had notified all who had ordered the package that they could have a refund if they so desired. He also said that they hoped to have the package together shortly and further stated that the package would not be totally compatible with MOS Technology's cross assembler mnemonics and operations (as had been indicated in a spec sheet that I had received).

I would never have mentioned this had I known that it was not yet available, and recommend that you hold off ordering anything from this Company until I can verify that their software is, in fact, available for purchase.

While I am on the subject, I have also received several letters indicating problems with interfacing KIM to OSI memory boards. One possible problem became apparent after a cursory inspection of the OSI application note on the subject. Address lines 10, 11, and 12 are driving a 74145 decoder on the KIM board. OSI recommends the use of 7417 buffers on all address lines. Since a 6502 can only drive 1 TTL load, problems can arise when address lines 10, 11, and 12 attempt to drive 2 TTL loads, as would be the case when driving both the on board 74145 and the 7417. Does anyone have more information about this interface?

One solution to the problem would be to simply replace the on board 74145 decoder with a 74LS145 low power Schottky device and use 8T97 buffers instead of the 7417's. The only problem is trying to find a 74LS145 (can anyone help out?).

Some of you have no doubt received the "uP4" (a newsletter) from Johnson Computer, P.O. Box 523, Medina, Ohio 44256. (Tel. # 216-725-4530). Although primarily an advertising brochure, the "uP4" also contains data on MOS Techs latest chip offerings and other tidbits of information of interest to most 6502 users. If you haven't received it, and want a free copy, write to them. They stock most MOS products (except for the KIM 4 Motherboard and the 6522 VIA - neither of which has been released as of yet). They also stock the MOS 7529-103 Scientific Calculator Chip (available for \$20.65, including postage, handling, and the 20 page documentation package) which will be interfaced to KIM in the next issue of the KIM-1 User Notes. I bought my chip from them so I know for sure that they stock them. They also stock Kim-2,3.

Coming Up In The User Notes

The Ultimate Calculator Interface - uses the 7529-103 calc. chip, and interfaces directly to KIM's I/O ports with the addition of 9-750 ohm resistors. No special power requirements (just 5 volts and ground) and no other chips are needed. A basic software driver will also be included. This interface was released as an application note from MOS but the I/O configuration and software had to be modified for KIM-1 operation.

KIM-1 Expansion - A series of articles will be started pertaining to the expansion of KIM into a complete system.

ACHESS CLOCK, REAL-TIME CLOCKS, HARDWARE INTERFACES

Plus more games, music programs, and letters from Users, etc, etc.

(also reprints from the Complimentary July issue of USER NOTES)

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On PLEASE

I received a complete PLEASE software package (mentioned in issue #2) from MicroCosmos, 210 Daniel Webster Hwy., So. Nashua, N.H. 03060. Even though I couldn't get the cassette tape to load correctly, I was quite impressed with the documentation that was provided. The source and object code listing is very well commented and the interpreter and monitor routines are explained in full detail. PLEASE includes a number of interesting games, puzzles and useful routines (hex to decimal, decimal to hex, among others). Information is presented which will enable you to use the PLEASE monitor routines for your own programs. I have talked with several people who had no trouble reading the cassette so my case is probably the exception rather than the rule. Robert Tripp, author of PLEASE, has indicated plans for making other software packages available in the future.

On MICROCHESS

Peter Jennings says that his chess playing program is now available ^{and} runs on the basic KIM with no additional memory or I/O. Peter goes on to say that for \$10.00 he will provide a Players Manual, a Programmers Manual, and a complete commented source listing of the program. He also states that the program is expandable, provided additional memory is added to KIM. For more information contact: MICROCHESS, 1612-43 Thorncliffe Pk. Drive, Toronto, Ontario, Canada M4H 1J4

If you have interfaced KIM to the Southwest Technical Products GT-6144 Graphic Display (or if you are planning on doing so) Stan Ockers, RR#4, Box 209, Lockport, Ill. 60441, would like to exchange ideas with you. Stan says he has it up and running.

Rene Vega, 4211 Avery, Detroit, Mich. 48208, had added some enhancements to Tiny Basic, plans more, and wants to exchange thoughts with interested people.

HORSERACE

Eight lap horse race and you can be the jockey and whip your horse to go faster. Warning-- whip the horse too much and he probably poops out.

two offerings from:
Charles K. Eaton
19606 Gary Ave.,
Sunnyvale, Cal
94086

<u>Horse</u>	<u>Track</u>	<u>Whipping button</u>
Prince Charming	top	PC
Colorado Cowboy	middle	C
Irish Rair	bottom	4

Start program at 027F. Race is 8 laps.

```
0270 XX XX XX XX XX XX XX XX XX XX XX XX XX XX D8
0280 A2 13 BD 7C 03 95 7C CA 10 F8 A9 7F 8D 41 17 A0
0290 00 A2 09 B9 7C 00 94 FC 20 4E 1F C8 C0 06 90 F3
02A0 20 3D 1F A5 8F 30 E3 A2 03 CA 30 DE D6 86 D0 F9
02B0 86 99 A4 99 B6 83 B9 90 03 35 7C 54 54 EA EA EA
02C0 95 7C E8 96 83 B9 90 03 49 FF 15 7C 95 7C E0 05
02D0 30 38 D0 06 A5 8F F0 28 D0 30 A2 02 38 B5 83 E9
02E0 06 95 83 CA 10 F6 A2 06 B5 7C 95 76 A9 80 95 7C
02F0 CA D0 F5 EA EA EA EA EA EA EA EA EA EA EA EA
0300 C6 8F D0 06 A5 81 09 06 95 81 EA EA EA EA EA EA
0310 B9 99 00 F0 0B 20 68 03 29 3C D0 1B 99 89 00 EA
0320 20 68 03 29 38 85 9A B9 8C 00 30 0B 29 38 c5 9A
0330 80 05 A9 FF 99 99 00 20 3d 1F A0 FF A6 99 3D 93
0340 03 f0 01 84 94 55 89 85 9A EA EA 20 68 03 38 29
0350 01 65 9A 18 A6 99 75 8C EA EA EA EA EA EA EA EA
0360 95 8c 95 86 4c a9 02 xx 38 A5 92 65 95 65 96 85
0370 91 A2 04 B5 91 95 92 CA 10 F9 60 XX 80 80 80 80
0380 80 80 80 FF FF FF 80 80 80 00 00 00 80 80 80 08
0390 FE BF F7 01 02 04
```

Thanks to Jim Butterfield for the original idea, my wife for the whipping suggestion, and Jim Butterfield, again, for the display routine and random number generator.

NOTE ON MOONLANDER

Terrific program, but we were wondering why it sometimes slips into fuel mode. It turns out this is from using the GETKEY subroutine in decimal mode. This routine sets the accumulator equal to 15 (Hex) if it finds no key pushed. But that's the decimal code for 'F', so under the condition that it branches into GETKEY because there is a key depressed, and the key is lifted before execution of the subroutine, MOONLANDER interprets the 15 default value as a depressed 'F' key. Easiest solution--change step 0092 to 14 and now 'E' (Energy) will be the button for fuel mode.

P.21

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FROM THE FACTORY

FROM THE FACTORY: Problems with some 6502 chips.

I have been informed of two possible problem areas with the 6502 CPU. Some of the early CPU's didn't set the zero flag correctly after register to register transfers (TAX, TAY, TYA etc). This would make it impossible to run Tiny Basic. All 6502 CPUs could have problems setting the zero flag after decimal addition when the answer equalled zero. Test your CPU with a simple program to see if you have these problems. The decimal addition problem can be gotten around by an "OR" immediate with "00" after the operation which would then set the zero flag correctly. The only method of solving the register transfer not setting zero flag would be to install a new CPU. (You would then pick up the "ROR" rotate right instruction in the process).

Copying KIM cassette tapes:

If you've tried copying KIM tapes from cassette to cassette then you already know that the copies will not be read correctly by KIM. The fix? Simply tie a .02 uf capacitor to ground from the junction of R6 and R34. Now make the new master tape. Copies from this new master should be read correctly by KIM.

KIM-2 Memory expansion:

If you wish your KIM-2 (4K) memory module to reside in the 0400-13FF position already decoded by KIM, then read on: Wire - or the KIM K1, K2, K3, K4 decoder outputs together, add a 3.3K pull-up resistor to +5 volts and tie these four lines to the address line 12 input on the KIM-2, set all the on-board DIP switches to the "off" position, and you're all set!

INTRODUCTION TO KIM-1 ARCHITECTURE

J. Butterfield
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Canada

This is intended to be a beginner's guide to the way KIM-1 is put together. It's mostly a hardware description with (hopefully) explanatory notes.

Because every KIM-1 owner has three fat manuals on his system, complete with detailed drawings, I'll try to save space here by referring to these manuals wherever possible.

The Address and Data Busses.

Let's start with page 24 of the KIM-1 User Manual (KIM-1 Block Diagram, Figure 3.1). We're going to concentrate on those two pipes on the left: the Address and Data Busses.

Every microsecond, the 6502 microprocessor sends out an address over the sixteen lines of the address bus. Sixteen lines are enough to address any of the 65,536 memory locations that could be fitted to KIM-1 (you only have 3,328 active addresses in the basic unit). In addition, there are a couple of other lines that accompany this bus: a Read/Write line (R/W) to tell whether the microprocessor wants to read or write memory; and a timing line, $\phi 2$ (phi, pronounced fy, two; it's confusing on the diagram because the phi looks like a zero).

The address bus goes to all memories. The idea is that when an address is generated, one memory only (whether RAM, ROM, I/O or Timer) suddenly says, 'that's me!' and connects to the data bus. If the R/W line says, 'read', the memory concerned places its data onto the bus; if 'write', the memory takes the data from the bus (placed there by the microprocessor) and stores it. For every address, only one memory unit responds; the rest stay silent.

This points out a fundamental difference between the address and data busses. The address bus goes one way only: from the processor to the memory. But the data bus information flows both ways.

This calls for a special kind of circuitry to connect to the data bus, called 'tri-state'. Every device on the bus might be (1) sending; (2) receiving; or, (3) ignoring the bus. (That isn't exactly how tri-state is defined, but it's a good way to remember it).

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—The Editor—